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MODERN METHODS OF INVESTIGATION.

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The recent assertion of Cohnheim* that in certain conditions of the parts involved white blood corpuscles are capable of migrating through the walls of capillary blood vessels into perivascular areas, is a convenient theme to employ in briefly reviewing the modern theories of pathology—their significance and origin.

In 1846, Aug. Waller,† in examining the mesentery of a toad and the tongue of a frog, found that both the red and the white corpuscles may traverse the walls of the capillary vessels. In addition to the above inquiry we will endeavor to ascertain why it was that Waller's experiments were, soon after their appearance, consigned to obscurity, while a quick recognition awaited their repetition fifteen years afterward.

There can be but little doubt, although there are many who ignore it (indeed, sufficient to influence medical education in this country), that from the natural sciences is derived the idea which underlies and gives tone to the thought of the century. The discernment of the presence of plans of structure and laws of life in the organic world; the exchange of artificial for natural systems of classification by Cuvier and Jussieu; and more especially the establishment by the former of the law of correlation of structure, have exerted an influence over the thinking world that continues to give a decided bias to its investigations.

It is not a little remarkable that one of the chief subsequent causes determining this should have had its origin with one less frequently associated with science than with literature, but who, in reality, belongs to both. We allude to Goethe, who has vari-

* Virchow's Archiv. Band, 40, 38. Prof. Kaloman Balogh (Archiv. de Physiologie, 1869, 152) has carefully repeated these experiments, without, however, confirming Cohnheim's conclusions.

† Lond. Edin. and Dublin Philosophical Magazine, 1846, vol. xxix, p. 271.

ously expressed in his writings the grand truths of primal harmonies, and of the inherent capacity for development possessed by both forms and ideas, which are pronounced in the law of the morphology of the plant, and in the theory of the construction of the skull, as well as in his strictly literary productions, such as Faust and Wilhelm Meister.

A numerous corps of writers, following in the same direction, have since so far welded science and literature together that they may be said to have now a common object. At all events, such an effect upon medicine is decided, and while perhaps unconscious of its influence, our investigators have demonstrated in the medical history of the nineteenth century their belief, or at least obedience to the philosophic teachings about them.

I.

The celebrated theories of our time have severally arisen as legitimate sequences of purely abstract investigation. The founding of general anatomy, comparative anatomy and zoology, were essential to the origin of such theories. We will accept this as a basis to assume—as we believe we justly can—that all we have that is true in pathology can be traced back to the time of the founding of these sciences on the schools respectively of Bichat and Cuvier. The names of men attached to this or that hypothesis are, as a rule, those of go-betweens, who, in search of novelty in striving to explain the obscure processes of tissue change, unconsciously it may be, often appear to the profession under false pretences. Thus the discovery of multiplication of cells by division by Mohl in 1835, was as essential to the theory of Schwann, as it was to the subsequent cellular pathology of Virchow. These distinguished men deserve all the reputation they have secured, but they are just so far indebted to Mohl, who appears to have done for vegetable what Bichat did for animal anatomy—that they were simply ingenious in applying his facts to their inferences and wants.

The establishment of embryology by Von Baer,* in 1828, and the dissemination of the general features of development of the embryo, gave to Goodsir his occasion for the doctrine of centres of nutrition, and to Beale for that of the germinal theory of his-

* Von Baer first applied embryology to classification of animals. He acknowledges Dollinger to have been his master, whose writings date fourteen years earlier.

togenesis. The introduction of the same truths to the field of surgical pathology by Paget, has given British surgery a tone which has done much to elevate this department of medicine in other countries, besides securing for its author a brilliant reputation.

In 1830 Ehrenberg discovered that in slow-moving or stagnant waters a numerous life was constantly present, whose forms were, for the most part, members of the lowest division of the animal kingdom. The line of research thus opened by him has demonstrated that an organism can be as simple in construction as a cell, and that the differences between them are not so much those of outline as of action. Since it has been shown that detached masses of "germinal matter" may appear in globular masses in the blood as white blood corpuscles, in mucous as mucous corpuscles, in pus as pus corpuscles—always maintaining an identity, and securing, by a more or less irregular and contractile form, a resemblance to one of the lowest of organisms *—a tendency has been evinced by some observers to assume that such and other like masses within animal fluids are not essentially different from simple and semi-homogeneous organisms without. We are thus prepared for a theory dependent upon the motion of such ultimate particles, viz., that of Cohnheim; and are not surprised that another observer † finds a great variety of distinct entities in the blood, among which he definitely enumerates the following: "Zoosporoid cells, animalcular bodies, diatoms, dismidiæ (*sic*), algoid cells and filaments, and fungoid spores." ‡

The same tendency is observable in other writers. Mr. Beale § inclines to the opinion that germs of bacteria may possibly exist in the salivary corpuscles. Dr. J. G. Richardson ‖ directly asserts their presence, and in a later paper ¶ employs them in explaining therapeutical action. The same writer ** affirms, from experi-

* AMŒBA, a genus of Protozoa. Hence the movements of these masses are characterized as amœbaform; or, more properly, amœboid.

† Dr. Salisbury; see in refutation a paper by Prof. H. C. Wood, jr. entitled, Production of General Diseases by Organic Entities. Amer. Jour. of Med. Science, Oct. 1868, 336.

‡ Many of these names have no existence in the technology of science. Our author might have continued his ingenious nomenclature by splicing words somewhat after this fashion: celloid spore, sporoid cell, zoo-algoid filaments. etc.

§ Microscope in Practical Medicine. Amer. edit. 1867, 176.

‖ Amer. Jour. Med. Science, July, 1868, 291.

¶ The Identity of the White Corpuscles of the Blood with the Salivary Pus and Mucous Corpuscles. Penna. Hosp. Reports, vol. ii. 1869, 254.

** Experiments showing the Occurrence of Vegetable Organisms in Human Blood. Amer. Jour. of Med. Science, July, 1868, 291.

ments on his own person, that the "bacteria" of the blood can be increased in numbers by swallowing "a fluid ounce of water, which contained, by estimate, 7,000,000,000 of living organisms."

The *escape* of a white corpuscle from the blood is but a step removed from the assumed possibility of the *entrance* of bacteria into that fluid. If these active organisms can get into the blood through the walls of the capillaries of the alimentary canal, it is fair to suppose that they can as readily get out again. On this supposition we claim in advance the discovery that the so-called corpuscles of Cohnheim are, in reality, nothing but escaped bacteria.

II.

In the same manner the different theories of inflammation may be found dependent upon similar precedents. Thirty years ago the theory of "action of vessels" was thought to be a great advance, as, indeed, in some respects—as, for example, in ascertaining the degree and nature of the increased temperature—it undoubtedly was, upon notions prevalent at that time. How completely a knowledge of development of the embryo changed such teachings, may be learned by the perusal of Burdach,* or by what is to us more familiar, of Paget's Lectures on Inflammation;† as well as to the deductions of the same school as announced by Simon turning the time-honored position of Travers and Muller, when he says: "In the primordial development of parts, we are able, without difficulty, to satisfy ourselves that organs which subsequently become dependent on blood vessels do at first grow quite extra-vascularly * * if, to use terms implying the relation of cause and effect between the intimate structure of such organs and their vascularity, we speak of the structure as determining the vascularity, but by no means of the vascularity as determining the structure. * * * The change of molecular structure determines the change of vascular supply."‡

In a more recent communication,§ the same author announces

* Physiologie, iv. 422.

† Lectures on Recent Progress of Anatomy, etc. London, 1851, 9.

‡ Lectures on Pathology. London, 1850, 67.

§ Holmes' System of Surgery, London, i. 1860, 16 Mr. Simon is inclined to attribute the "extra-vascular" theory to Prochaska, as far back as 1778. We have already remarked that the French school, as represented by Bichat and Cuvier, has been accepted as the basis of our scheme. We are inclined to believe that interpretation of modern discovery by the generaliza-

that "tissues are independent of blood vessels, except for the administration of food and the removal of refuse; that they develope or grow by the life of their own germs, and according to the several patterns which they respectively inherit; this doctrine, now almost universally accepted, has only been possible since the great discovery of Schwann."

The fact that the processes of inflammation are exhibited without the presence of blood vessels, gives plausibility to the position of Cohnheim. Since with him the structural elements of inflammation escape through openings in the walls of the blood-vessels, thus rendering the vessel as passive an agent as the orifice of a vessel in an animal with an interrupted circulation—such as a mollusc—where the blood corpuscles pour out into irregular tissue interspaces.

We see, therefore, that researches in natural science, more particularly in the departments of minute anatomy, have been a source of inspiration to our pathologists.* At the same time (and it may be in consequence of the connection between the two), there is often evident in their writings a certain weakness of grasp. This we believe to be a result of a faulty method employed. They have taken note of nothing in man but his tissues, nothing in nature but her crude materials. They have studied the cell almost exhaustively, its anatomy, properties and history, but have failed to comprehend the significance of their aggregation: in a word, of the presence of plans in nature.

Cuvier founded, *par excellence*, an architectural system. He demonstrated the plans of the divine builder, and places "tissue" subservient to their erection. Histology he proves to be not so much a science as a division of a science. When it was said of her votaries that, after all their ministration, she could not claim through their labors a single law, it was ignorantly said. The

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tions of writers antecedent to this time, may afford an illustration of what Lewes calls, in speaking of many discoveries which have presumedly been traced to Aristotle, of reading in ancient texts the thoughts of modern thinkers.

* Did space permit, we might trace many theories of causation of special diseases to discoveries (more particularly by Mulder) in organic chemistry. "At the present day," says Henle, (General Pathology, Eng. Trans., 1853, 28,) "a theory is sure of instantaneous success in which the pathological process diverts from a hypothesis based upon the apparent or real increase of any one of the constituents of the blood, * * * since the mania to reduce the totality of symptoms to differences of quantity depends upon the same causes as the passion for systems in general."

laws of organic structure are to be found only in forms made up of histologic elements.

Let us glance for a moment at the plans or types of the animal kingdom. As defined by Cuvier, they are four in number, corresponding to the great divisions Vertebrata, Articulata, Mollusca and Radiata. In a large inferior group the Protozoa, owing to the extreme simplicity of their organization, no plans have been detected, yet we must conclude that here as elsewhere design is present.*

Now what is the exact value of these plans?

Maclise has said,† "there can be no more striking proof of the divinity of design than by such revelations as anatomical science everywhere reveals, viz., that every organ serves in most cases a double, and in many a triple, purpose in the animal economy."

We can in the same way postulate, without dogmatism, that there is a profound wisdom in the creation of a plan. Nothing, we agree, is created without a purpose. What may be the purpose, therefore, or the effect upon its relation to the individual, of the presence of a plan when it pronounces itself in the egg, fashions every stage of development, influences habit, and controls its functions as well as determines its shape? Certainly something so constant and deep-lying that we can not but conclude that it also operates in conditions of disease.‡

Accepting the Socratic definition that disease is "disarrangement of the body," we will naturally expect to find that of two animals, each suffering from a 'disarrangement,' will agree or differ from one another as the original arrangement of their parts may be alike or unlike. Thus a disease of a vertebrate will vary in its characters from a disease of a mollusc, since the types of these two classes of animals are in themselves different.

A few examples may be given of what we conceive to be errors

* All the original Cuvierian plans have undergone modification, except that of the Vertebrata. The Articulata and Mollusca have by some been sub-divided, while the group of the Protozoa has been created from the Radiata. This is, for our purpose, immaterial. It is of the importance of bearing in mind the existence of plans we are discussing, and not of the number which may be observed in nature.

† Surgical Anatomy, Amer. edit. 1859, 10.

‡ Equally to the point are the aphorisms of Henle (q. v. supra): "Disease is a deviation from the type according to which organic beings develop themselves" (p. 109). "Type is the law which determines the form of natural bodies." "Disease is the manifestation of typical forms under unusual conditions," (p. 115.) "Development deviating from the destined aim is the pathological process," (p. 124).

of judgment, arising from misconception or ignorance of this, the true method of investigation.

One physiologist endeavors to throw light upon the problem of double embryo in the bird by mentioning the fact that in many molluscs four or five embryos may arise from within a single chorion, as in the sea-hare (*Aplysia*).* Another, speaking of the transposition of viscera in the human subject, finds analogy and fellowship in somewhat similar dispositions occurring in certain univalve molluscs.†

A third observer detects an abscess in an oyster—the presumed result of a process of inflammation, without, however, as we must conclude, any of the symptoms being present by which it is elsewhere recognized. The assertion is suggestive of an extreme improbability whether anything comparable to an inflammatory process *can* be observed within the Mollusca. There is, perhaps, a shade more reason in the assertion that within the dermoid cysts of the human ovary, with their contents of teeth and hair, we find an example, confined nominally to the Invertebrata, of a budding or germinating process, similar to that observed in certain worms or insects.‡ Much less probable, however, is the relation suggested by Paget, that certain forms of the cartilage cell met with in cartilaginous tumors from the human subject, "deviating from what is natural in its own species, conforms with that of a lower creature." Had this "lower creature" been a reptile, frog, fish, or any other animal within the Vertebrata instead of a cuttlefish (a mollusc) we would have been better satisfied with our author's conclusion.

Not only do unbridgeable intervals obtain between animals of different plans of construction, but between those of the same natural division they may be sufficiently marked to occasion doubts on the part of the observer, whether his conclusions may be properly applied to any other animal than the one immediately under notice. Thus, even within the well defined division of the Vertebrata, the aquatic forms have lives differing from the air-breathing from the earliest stage of egg life. Any attempt to explain processes going on in the latter by studies carried on in the former may be open to objection.

Let us examine the common frog so generally employed in

* Lewes' Sea-Side Studies.

† Baukart, Pye, Smith, and Phillips. Guy's Hosp. Rep. 1869.

‡ S. J. A. Salter. Holmes' System of Surgery, vol. iv. 32, note.

experimentation. The egg and tadpole conditions of this animal are aquatic. It is, therefore, without amnion or allantois. It aerates, when adult, through the common integument. It possesses a lymphatic circulation of great proportionate development, while it has a mixed cold blood. May not the intricate processes of inflammation differ in some essential feature from the same as witnessed in a warm-blooded animal? Is it rational to expect to find in a creature adapted to habits all of which would be fatal to man, the conditions favorable for experiments, the object of which is to explain processes going on within his own tissues? The single observation of Paget on the action of an irritant on the outstretched wing of a bat proved, we think, for the first time, the conclusions with respect to the change in the disposition and behavior of blood corpuscles in an irritated area.* Cohnheim has taken the frog for experimentation. His results are interesting as a study in comparative pathology, but they can not, we believe, have more than a suggestive value. Until they had been confirmed in the bat or some other animal, their application to mammalian pathology—even in the absence of Professor Balogh's observation—the verdict should have been given, as in every other instance—not proven.†

We can now understand why Waller's experiments fell still-born, while Cohnheim's attained an early notoriety. The average mind of the profession was not prepared to accept, in 1846, what seems correct enough in 1869. White corpuscles wore then less protean shapes than now, while it was rank heresy to dispute the specific quality of the mucous, pus, and salivary corpuscles. Much less was it believed that the blood held quite a little fauna and flora of its own, and that all that was necessary to prove the assertion was to look for the animals. A few years of such surroundings prepared the mind to notice a theory which appeared to harmonize with such increased knowledge of minute animals, and of actions of living matter.

Following up this train of reflection, it would be curious to speculate upon the different expressions theory may assume hereafter. No one can tell what that germ of thought may be now revealing itself to the mental gaze of the medical philosopher of the future, or in what way it will modify our present interpretations of nature. Of this, however, we feel assured, that if it do not conform to, or be in harmony with, the simple and grand truth of the presence of variety of design, not only in form but in function, it will not stand.

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* Wharton Jones' original studies were made upon cold blooded animals in 1849. Paget experimented on the bat in 1850. Apparently acknowledging his faulty method, the former observer repeated his labors, in 1853, upon warm blooded animals. His first memoir, however, appears to have been more frequently quoted than the last. See Medico-Chirurg. Trans. xxxvi. 391.

† It is but justice to state that Cohnheim also employed the rabbit in his investigations.